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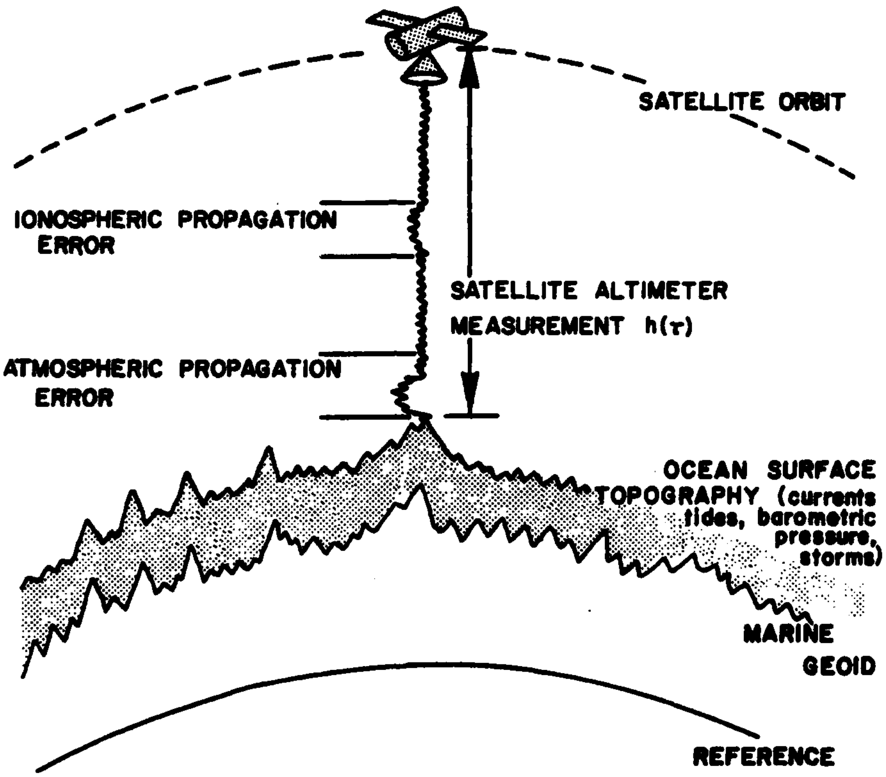

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ABSTRACT

The GEOSAT satellite, to be launched in FY-84, will carry a microwave altimeter. NORDA has responsibility for implementing an operational demonstration at Fleet Numerical Oceanography Center (FNOC) in which oceanographic products utilizing information obtained from the altimeter are the result. Substantial preparation will be required. This note outlines the current status of available processing algorithms. Existing software that was used for SEASAT forms a starting point; that software and its limitations are reviewed. The SEASAT software as used did not take advantage of (or test) its full design capabilities, primarily because of the shortness of the mission and because certain information was unavailable. Current studies that build on newer developments in the interpretation of altimeter data are also described, along with a summary of background material. Some of the new studies are directed specifically toward the detection and monitoring of mesoscale features, which will be a goal of the operational demonstration and which was not a part of the routine SEASAT processing. The results of the ongoing studies will clarify the scope of the required algorithm development effort.

OCEAN ALTIMETRY ALGORITHMS STATUS:

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1. INTRODUCTION

GEOSAT is a satellite, scheduled for launch in FY-84, that will carry a single instrument--a nadir-looking microwave altimeter virtually the same as the one aboard SEASAT. The primary mission is geodesy. However, since deviations of sea surface height from the marine geoid are related to dynamic effects in the ocean, a secondary mission will be oceanography.

Previous satellite altimetry (i.e., GEOS-3, SEASAT) has been processed to provide information routinely on surface wind speed and significant wave height. Other work (theoretical and experimental) has indicated that it may be possible to detect and monitor mesoscale ocean features. An operational demonstration for GEOSAT will be implemented at Fleet Numerical Oceanography Center (FNOC) in which altimeter data will be processed in near-real-time into Earth-located geophysical units and utilized in routine analysis and predictions of oceanographic parameters.

Clearly, preparation for this demonstration is a task of considerable magnitude and complexity. This report summarizes information about the processing and measurement algorithms. It describes the "production" software that was used for processing SEASAT altimetry, and should form a foundation for the GEOSAT software. It also discusses some work on the interpretation of altimeter data to provide other kinds of information. Finally, it describes current efforts directed toward recommending and developing software for the GEOSAT operational demonstration.

2. EXISTING ALGORITHMS

2.1 SEASAT ALGORITHMS

No production algorithms for the GEOSAT altimeter have been written and documented. However, since the SEASAT altimeter was virtually identical, the software written for it is of interest. Two sets of software to be discussed are the Jet Propulsion Laboratory (JPL) of the California Institute of Technology software and the FNOC software.

The JPL software was used to do the production processing of SEASAT data for the National Oceanic and Atmospheric Administration (NOAA) Environmental Data and Information Service (EDIS). There are two methods of categorizing the JPL software: by function and by output product. The five functional categories are listed in Table 1 (the references are shown in parentheses). The categorization by output product subdivides the software into three groups as follows:

Table 1. Functional classification of SEASAT processing algorithms (Hancock, 1980)

Category	Description
1. Housekeeping	Instrument sorting, time sorting, blunder point editing, unit conversion, quality editing.
2. Instrument corrections	Adjustments of the data to account for known instrument biases.
3. Atmospheric corrections	Adjustments of the data to account for atmospheric (including ionospheric) effects on the signal.
4. Geophysical corrections	Adjustments due to geophysical effects such height, tides, and atmospheric pressure.
5. Location processing	Positioning the footprint in latitude and longitude.

The first group is carried out in JPL's Instrument Data Processing System (IDPS). The basic output is the sensor data record (SDR). The sensor data serves as input to JPL's Algorithm Development Facility (ADF), where processing into geophysical data is performed in two stages. The corrections for (primarily) sensor-related biases produce a sensor file. Then, the application of geophysical corrections results in the final geophysical data record (GDR) file. The primary sources of information on these algorithms were Hancock et al., 1980; SEASAT Instrument Data Processing System Capabilities and Operations Guide, 1979; Lorell, 1980; SEASAT Geophysical Data Record Users Handbook, 1980a; and SEASAT Altimeter Geophysical Algorithm Specifications, 1980b).

The IDPS algorithms start with the raw data and time-order, decommutate, convert the raw counts to engineering units, correct for attitude, and Earth-locate the data. The entire data system from all of the SEASAT instruments except the synthetic aperture radar (SAR) is processed by these routines.

Several subsystems are included in the IDPS software; they are known as SEASDR, SEAFILE, SEACATALOG, SEASTRAIN, SEATABLE, SEADUMP, CTAB/CPLOT, and AO Compress. The SEASDR and SEASTRAIN subsystems are primarily of interest here. The others are used for various "bookkeeping", table maintenance, printouts and similar functions. The following is based on the SEASAT Instrument Data Processing System Capabilities and Operations Guide (1979).

The SEASDR subsystem is the largest and most complicated of the eight IDPS subsystems. It processes the input control card decks, initializes EU tables, SPS tables and zone maps produced by SEAFILE, and validates files on the AO tape prior to processing S/C telemetry data. (Abbreviations used here are defined in Table 2.) Input PMDF tapes are first validated, then spacecraft telemetry blocks are extracted and minor frames built. SEASDR then moves the telemetry data channels within the minor frame to the proper location for the output and makes any necessary DN/EU conversions. Using attitude and orbit files from NASA-GSFC the science data is Earth located. Each instrument footprint that lies within one or more predefined regions, defined by zone maps, is flagged accordingly. These zone flags can be used later by SEASTRAIN for data selection. The performance of selected science and engineering data channels is monitored using SPS capability. Data accountability reports are compiled for each input and each output telemetry data tape volume, and printed at run completion. A catalog entry is generated for each MSDR tape produced by SEASDR. Processed telemetry data can be written to as many as eight different tape volumes defined as instrument SDRs or an MSDR.

The SEASDR subsystem has as input PMDF tapes, AO tape, SEAFILE tables (disk resident channel, EU, and SPS tables and zone maps), and card inputs. It produces SDR and MSDR tape files, SPS reports, punched cards for each tape written, catalog abstract records, a data gap summary, input and output tape summaries, a discarded

Table 2. Definition of abbreviations for IDPS software (SEASAT, 1979a)

AO	Attitude/Orbit
DN	Data Number
DSN	Data Set Name
EU	Engineering Unit
FLDR	Fixed Location Data Record
MSDR	Master Sensor Data Record
PMDF	Project Master Data File
S/C	Spacecraft
SDR	Sensor Data Record
SPS	Sensor Performance Summary

block display, a zone map print display, and output status messages. A tape file can be an SDR, containing data for one instrument, or an MSDR, containing data for all instruments.

Altimeter SDRs are of interest here. They can also be produced by SEASTRAIN.

The SEASTRAIN subsystem is used to strain selected data from MSDR tapes. MSDR tape volume numbers and DSN, data type zone(s), and start/stop times are input to SEASTRAIN via data cards. The data from MSDR tapes is input to the program and validated. Output data selected by data type and time produces an SDR. Output data selected using zone flags produces an FLDR. Additionally, SEASTRAIN can recompute the zone flags using a new set of maps produced by SEAFILE. This capability will allow selection of data from zones that were not defined when data was originally processed by SEASDR. Job run summaries describe the quantity and identify time period on tape products.

The primary use of SEASTRAIN is to produce SDRs from the MSDRs, which contain data frames from all of the spacecraft sensors on a single tape volume for a specified period of time. SEASTRAIN is used to select only those SDRs requested by a given experimenter. The subsystem uses as input MSDR files and job control information. The processor produces SDR tapes, job run summaries, and SDR punch card catalog entries. (An SDR produced by SEASTRAIN may contain data received from one or more spacecraft instruments; the latter option is of no interest for GEOSAT applications.)

The next stage of processing is applied to the altimeter SDRs. It applies instrument calibrations and corrections, converts some data to radar parameters (e.g., AGC to scattering cross section), performs blunder point editing and data compression. The result is a sensor file, which contains corrected data, the corrections, and flags to identify blunder points and out-of-limit engineering parameters.

An input processor reads the SDR and organizes the data for use by the ADF sensor file algorithms. Those algorithms and their functions are listed in Table 3; refer to Lorell (1980) for flowcharts that depict the order of processing, and for other detailed information.

The third stage of processing operates on the sensor file and produces a GDR file. The precise orbit is applied, along with corrections for atmospheric and ocean surface influences, tides, and the geoid. A number of the sensor file results are simply passed on to the geophysical file. Others are acted on by algorithms of three types: location, atmospheric, and geophysical algorithms.

Table 4 lists the ADF GDR algorithms. The format is similar to that of Table 3. The information primarily comes from the SEASAT Altimeter Geophysical Algorithm Specifications (SEASAT, 1980b). SEASAT (1980a) and (1980b) contain more information on GDR processing and on the overall data and processing flow.

The FNOC software was written earlier than the JPL software. It is simpler and less sophisticated than the latter. For example, the GDR processing consists simply of making three corrections to the waveheight values (attitude-sea state correction to H 1/3, prelaunch calibration for H 1/3, and H 1/3 bias) and averaging together ten frames to obtain one-second averages (SEASAT-A, 1979a and 1979b). (The latter reference (SEASAT-A, 1979b) noted that only the first two corrections were performed at the time that document was written, pending receipt of data from JPL.) References that provide more information on the FNOC altimeter software are SEASAT-A, 1979a; SEASAT-A, 1979b; SEASAT, 1979b.

Table 3. JPL Algorithm Development Facility altimeter sensor file algorithms (Lorell, 1980)

Program Identifier	Function Performed	Functional Category*
AL.IG.S-04/0/E	Data compression, standard deviations	1
AL.IG.S-14/0/E	Units change (h, h' from round-trip light time to meters)	1
AL.IG.S-30/0/E	Operating mode edit (pass only valid dots)	1
AL.IG.S-31/0/G	Engineering quality calculation and flag (for out-of-limits data)	1
AL.IG.S-33/0/E	h-blunder point calculation/flag	1
AL.IG.S-35/0/E	$H_{1/3}$-blunder point calculation/flag	1
AL.IG.S-01/0/E	Time tag correction	2
AL.IG.S-01.01/0/E	Track mode correction to time tag, constant part	2
AL.IG.S-01.02/0/E	Track mode correction to time tag, variable part	2
AL.IG.S-03/0/E	Compute height acceleration	2
AL.IG.S-03.01/0/E	Height correction because of height acceleration	2
AL.IG.S-05/0/E	Cal mode correction to h	2
AL.IG.S-06/0/E	Attitude-sea state correction to h	2
AL.IG.S-07/0/E	Center of gravity correction	2
AL.IG.S-09/0/E	Cal zone bias on h	2
AL.IG.S-12/0/E	Edit according to blunder point flags, engineering quality flags, and track mode flag	2
AL.IG.S-13/0/E	Sum instrument corrections to h	2
AL.IG.S-15/0/E	$H_{1/3}$ bias	2
AL.IG.S-16/0/E	Attitude-sea state correction to $H_{1/3}$	2
AL.IG.S-19/0/E	Sum instrument corrections to $H_{1/3}$	2
AL.IG.S-34/0/E	Prelaunch calibration, $H_{1/3}$	2
AL.IG.S-36/0/E	Backscatter cross section	2

*Numbers keyed to Table 1.

Table 4. JPL Algorithm Development Facility Altimeter GDR Algorithms (SEASAT, 1980b)

Program Identifier	Function Performed	Functional Category*
AL.IG.G-10/0C	Ionospheric pathlength correction	3
AL.IG.G-11.00/1/B	SMMR wet troposphere correction interpolate	3
AL.IG.G-11.11/1/B	SMMR wet troposphere correction	3
AL.IG.G-11/2/A	FNOC wet troposphere correction	3
AL.IG.G-12/0/B	Dry tropospheric pathlength correction	3
AL.IG.G-14/0/B	Net atmospheric correction (with the FNOC wet tropospheric correction)	3
AL.IG.G-17/1/A	FNOC interpolate (used as a preprocessor for input to next algorithm)	3
AL.IG.G-17/2/A	FNOC interpolate (from a set of files preprocessed to an approximate SEASAT orbit)	3
AL.IG.G-01/0/A	Sea height above reference ellipsoid incuding instrument and atmospheric corrections (with the FNOC wet tropospheric correction)	4
AL.IG.G-02/0/A	Inverse barometer (barotropic) effect	4
AL.IG.G-03/3/B	Ocean tide model (Schwiderski)	4
AL.IG.G-03/4/A	Ocean tide model (Parke-Hendershott)	4
AL.IG.G-05/0/A	Solid earth tide	4
AL.IG.G-07/2/A	Geoid (GSFC 1 X 1° gravimetric GEM10B)	4
AL.IG.G-18/0/B	Estimate nadir wind speed	4
AL.IG.G-19/0/A	SEASAT mean sea surface	4
AL.IG.G-04.00/1/B	Precision orbit read and interpolate (GSFC)	5
AL.IG.G-04.00/2/B	Precision orbit read and interpolate (NSWC)	5
AL.IG.G-04.01/0/A	Radial orbit difference (NSWC-GSFC)	5
AL.IG.G-15/0/B	Land-sea flag	5
AL.IG.G-20/0/A	Rev number	5

*Numbers keyed to Table 1.

2.2 LIMITATIONS OF SEASAT SOFTWARE

The JPL SEASAT altimeter software represents a thorough approach to the processing problem. However, some of the algorithms were relatively primitive, and the full scope of processing intended in the design of the system was not realized for several reasons, as detailed below.

One general statement that was included in the documentation of the sensor file algorithms is significant and speaks for itself: "Several of the algorithms are designed to include accuracy information. However, as of this writing, most of the accuracy slots are filled with zeros since the required numbers are not yet available" (Lorell, 1980).

The sensor file algorithm designated as AL.IG.S-02.00 (cal mode computation) was disabled (Lorell, 1980). The results were intended for use in the cal mode correction to h routine (AL.IG.S-05/0/E). Because the mission only lasted three months and the calibration data for that period showed no measurable drift in the data reference, that correction was never made (Hancock et al., 1980).

Another algorithm affected by the shortness of the mission was AL.IG.S-01.01/0/E. The altimeter was designed to operate in one of four modes, designated by ground command. The correction implemented in this algorithm is mode-dependent. However, the mission ended before modes 2 and 3 were used. The corrections for modes 1 and 4 were the same constant. So the function of the algorithm simplified to providing only a single constant (Lorell, 1980).

Algorithm AL.IG.S-03.01/0/E was affected similarly. A coefficient used in the processing was mode-dependent, and only one value was actually used during the mission (Lorell, 1980).

The computation of height acceleration and the correction to h due to height acceleration were intended for use primarily over deep ocean trenches, where h can be large. It was found that algorithm AL.IG.S-03 was not appropriate for SEASAT data. The correction was estimated to be of the order of 3-4 cm at most, so it was decided not to revise the algorithm. The calculation was disabled by setting the height acceleration corretion (algorithm AL.IG.S-03.01) to zero (Hancock, 1980, and Lorell, 1980).

In algorithm AL.IG.S-13/0/E (sum instrument corrections to h), it was originally intended to include standard deviations of the individual corrections and of the combined correction. However, since accurate statistical information was not generally available for each data set, the standard deviations were set to zero (Lorell, 1980).

The attitude-seastate corrections to h and H 1/3 (algorithm S-06 and S-16) are examples of the situation described above, in which accuracy information is missing. Uncertainty values calculated by S-16 are zet to zero, and a table of uncertainties used by S-06 was not available. (Lorell, 1980).

Algorithm AL.IG.S-30/0/E (operating mode edit) was intended to process cal mode data. Because algorithm S-02 was disabled, that portion of the calculation was not used (Lorell, 1980).

The rev number algorithm (AL.IG.G-20/0/A) performs its calculation with the aid of a lookup table. The documentation notes that the table will not increment precisely at the ascending equator crossing (SEASAT, 1980b).

There are two algorithms for calculating the correction due to the change in atmospheric refractive index caused by tropospheric moisture content: SMMR wet troposphere correction (AL.IG.G-11.11/1/B) and FNOC wet troposphere correction (AL.IG.G-11/2/A). However, the net atmospheric correction algorithm (AL.IG.G-14/0/B) only used the FNOC wet troposphere correction. The SMMR correction was not used because of SMMR data gaps (SEASAT, 1980b).

The nadir wind speed algorithm (AL.IG.G-18/0/B) uses an empirical fit to wind data at 10m elevation. The subsequent conversion to 19.5m elevation is "arbitrary" (SEASAT, 1980b), a multiplicative constant.

Corrections must be made to h and H 1/3 to account for any tilt in the altimeter orientation. The SEASAT algorithms used a value for the tilt angle that was determined from ground-based processing of data from the onboard attitude system. It was discovered that the attitude as determined by waveform analysis sometimes disagreed with the value that was used in the GDR processing. The discrepancy was not explained (SEASAT, 1980a).

3. OTHER WORK

The foregoing section discussed the processing algorithms that were used to produce GDRs from SEASAT altimeter data. Largely, they should be adaptable to GEOSAT data, although conversion to another computer, if necessary, is a non-trivial task. In addition to the previously mentioned software, there have been many studies on various aspects of the analysis of altimetry. Two such aspects are waveform processing and objective techniques for detecting mesoscale oceanic features. The review of other work on altimetry algorithms is not exhaustive, but should give an ideal of the level of effort and the nature of the research results available now. Both fundamental and applied work has been performed.

Brown introduced a theoretical model for short pulse scattering from a statistically random planar surface with particular application to then-current state of the art radar altimetry. Two applications were presented: radar antenna pointing angle determination, and altitude bias correction for pointing angle and surface roughness effects (Brown, 1977).

In related work Brown presented an analytical approach to the problem of scattering by composite random surfaces; the surface height distribution was assumed to be Gaussian. A first-order perturbation result comprises a convolution in wavenumber space of the height spectrum, the shadowing function, a polarization-dependent factor, the joint density function for the large-scale slopes, and a truncation function which restricts the convolution to the domain corresponding to the small-scale height spectrum (Brown, 1978).

Jackson extended Brown's work to non-Gaussian surface height distributions. In Jackson's analysis non-Gaussian ocean wave statistics are accounted in a simple model of the reflection of radar impulses from the sea at near-vertical incidence. He found that the impulse response of the sea at vertical incidence is very nearly equal to the wave height pdf (probability density function). The mean of the distribution, however, is not located at true mean water level but is negatively biased in an amount equal to the height skewness coefficient times the rms wave height.

Jackson suggested that this sea state bias should be corrected for in the routine processing of satellite altimeter data (Jackson, 1979).

Lipa and Barrick examined the integral equation for the echo voltage in terms of the joint height-slope pdf that results from rough-surface scattering theory and developed inversion methods that do not require the assumption of a model for either the ocean surface or the transmitted pulse. The methods were applied to SEASAT data. Among other things, they identified a sea-state-dependent height bias essentially the same as that discussed by Jackson, and called it "electromagnetic bias." They cite the existence of this "E-M bias" in the data as proof that one must employ the joint height-slope pdf in the scattering model (Lipa and Barrick, 1981).

Hayne (1981) developed a method for estimating physical parameters from altimeter waveform data based largely on the above and similar work. In the method, averages of the waveform sampler data are fitted by varying parameters in a model mean return waveform. The model is the (numerical) convolution of three terms: the flat-sea impulse response, the surface elevation density function for "scattering elements," and the radar altimeter system point-target response. It should be noted that the pdf used is essentially that presented by Jackson. Hayne notes that Lipa and Barrick, and others, have proposed other forms, and points out that different forms can be accommodated by rewriting one subroutine. The model parameters which are determined by means of an iterative nonlinear least squares computation are amplitude, time origin (track point), sea surface rms elevation, average noise baseline, sea surface skewness, and attitude (off-nadir) angle. The form of the calculational procedure avoids an explicit numerical deconvolution, which would be noisy (Hayne, 1981).

The foregoing discussion has described waveform analysis work. The objective analysis techniques to be described next are directed toward detecting and monitoring eddies. They are based on a mathematical model of an eddy developed by Henrick et al (1977). They obtained an analytical solution to the basic equations of fluid motion, where the motions considered were assumed to be nearly in geostrophic and hydrostatic balance, and were potential-vorticity conserving to higher-order terms. The model reproduces four observed characteristics:

- Oceanic eddies are nearly circular, except possibly in their nascent and terminal stages.
- Eddies translate slowly, with speeds of the order of 5 cm/sec.
- Rotational currents and environmental effects of the eddy are assumed to vanish at a finite (dimensionless) distance from its center.
- Eddy effects are negligible in abyssal depths, so the model eddy has a limited extent in depth.

An approximate solution with these properties was found (Henrick et al., 1977).

Jacobson et al. (1979) used the model in a study designed to investigate the way an eddy expresses itself on the ocean surface. They concluded that there was a height deviation from the static ocean which is a maximum at the eddy center, and decreases steadily to zero on the eddy circumference. The maximum surface deviation calculated for a range of eddy sizes and strengths was of the order of 1m. They proposed a general method of approach for estimating eddy parameters from measurements made by a satellite-borne altimeter.

The work was continued in two Johns Hopkins University Applied Physics Laboratory (APL) internal reports. In the first, Ousborne applied an optimum (in the sense that it produces the best peformance, highest probability of detection or lowest probability of false alarm, while meeting the Neyman-Pearson criterion) detector for known signals embedded in Gaussian noise to the problem. He considered one-dimensional detection, i.e., one ground track through the eddy, and derived an expression for the signal-to-noise ratio (SNR). Based on the calculation, the preliminary conclusion was that two matched filters would be adequate for detecting eddies with a range of radii between 25 and 75 km. The loss in SNR due to mismatch (compared with using a separate filter for each eddy size) was calculated to be only 1 dB (Ousbourne, 1981a).

In the second of these reports Ousborne treated the case of processing simulated altimeter height data using a two-dimension maximum a posteriori (MAP) estimation-correlator detection algorithm. Further, he considered eddies moving with linear speeds up to 5 km/day. For median to fast-moving 50 km radius eddies the preliminary result for the expected reduction in probability of detection was less than 15% at a 25 km ground track separation and track time separation less than five days. (Other cases were also studied.) Methods of improving detector performance were suggested (Ousbourne, 1981b).

Henrick's model is based on data obtained by Parker (1971). More recent satellite observations of SST eddy signatures suggest that eddies may have an elliptical shape, the axes of which rotate slowly (Spence and Legeckis, 1981). Results of the French "Turbulon" experiment indicate that the vorticity vector field associated with eddies may not remain vertical at depth, but may "lean" over as depth increases.

4. ALGORITHM DEVELOPMENT EFFORT

The previous sections have described the existing software for routine processing of satellite altimeter data, as well as some research into new techniques. This section covers some ongoing efforts aimed at evaluating the need for new algorithms and beginning the development of the software. These studies are being conducted by APL, JPL and NORDA; the description of each is followed by the initials of the appropriate group.

Continuing an instrument error budget study currently being performed by NRL, significant geophysical noise sources and the characteristics of the sources which are important to mesoscale mapping (i.e., those which have similar spatial frequency content) will be identified. (APL, NORDA) The study will be continued to develop processing techniques for removing noise source not predicted by large-scale models. (APL)

Another current study concerns the feasibility of detecting, describing, and monitoring mesoscale oceanographic features utilizing altimeter data combined with other data sources (e.g., IR satellite imagery). It will continue by beginning the development of prototype software. (JPL, NORDA)

The objective analysis work described previously will be continued, to develop estimation and detection algorithms to produce characterizations of mesoscale features. (APL) In a related effort, a survey will be performed and recommendations will be made regarding algorithms for mesoscale modeling and related detection and monitoring techniques. (JPL)

In another study, the influence of atmospheric water vapor on mesoscale oceanographic feature detection will be assessed. Recommendations concerning techniques for dealing with the problem will be made. (JPL, NORDA)

A study will be performed to establish the required flow of data from the satellite to the end user, with particular attention devoted to hardware/software and software/software interfaces, data queues, and data processing. A preliminary plan for software implementation based on this study will be developed. (JPL)

A study of existing waveform processing algorithms relative to GEOSAT requirements will be performed, resulting in recommendations regarding those which could be implemented by FY-84. Also, a study will be conducted to identify those Navy (FNOC) oceanographic models which could benefit from GEOSAT altimeter data; the required data assimilation techniques will be surveyed. (JPL, NORDA)

NORDA's administrative role is to coordinate these studies and ensure that the software effort is directed toward a successful operational demonstration. These studies will help to define the required software development for that purpose. In a few months, when recommendations from these studies are available, the scope of that effort should be much clearer.

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The GEOSAT satellite, to be launched in FY-84, will carry a microwave altimeter. NORDA has responsibility for implementing an operational demonstration at Fleet Numerical Oceanography Center (FNOC) in which oceanographic products utilizing information obtained from the altimeter are the result. Substantial preparation will be required. This note outlines the current status of available processing algorithms. Existing software that was used for SEASAT forms a starting point; that software and its limitations are reviewed. The

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SEASAT software as used did not take advantage of (or test) its full design capabilities, primarily because of the shortness of the mission and because certain information was unavailable. Current studies that build on newer developments in the interpretation of altimeter data are also described, along with a summary of background material. Some of the new studies are directed specifically toward the detection and monitoring of mesoscale features, which will be a goal of the operational demonstration and which was not a part of the routine SEASAT processing. The results of the ongoing studies will clarify the scope of the required algorithm development effort.